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RESEARCH REPORT: RR 25701
(CSI # 03151)

BASED UPON ICC EVALUATION SERVICE
REPORT NO. ESR-1917

REEVALUATION DUE DATE
May 1, 2013
Issued Date: July 1, 2011
Code: 2011 LABC

GENERAL APPROVAL – Reevaluation/Technical Modification – Hilti Kwik Bolt TZ Carbon and Stainless Steel Anchors in Concrete.

DETAILS

The above assemblies and/or products are approved when in compliance with the description, use, identification and findings of Report No. ESR-1917, reissued May 1, 2011, of the ICC Evaluation Service, Incorporated. The report in its entirety is attached and made part of this general approval.

The parts of Report No. ESR-1917 which are excluded on the attached copy have been removed by the Los Angeles Building as not being included in this approval.

The approval is subject to the following conditions:

1. The allowable values listed in the attached report and tables are for the fasteners only. Connected members shall be checked for their capacity (which may govern).

2. The anchors shall be identified by labels on the packaging indicating the manufacturer's name and product designation.

3. The anchors shall be installed as per the attached manufacturer's instructions except as otherwise stated in this report. Copies of the installation instructions shall be available at each job site.

4. Design values and minimum embedment requirements shall be per Tables in ICC ES Report No. ESR-1917.

5. The concrete shall have attained its minimum design strength prior to installation of the anchors.

6. Special inspection in accordance with Section 1704 of the 2011 Los Angeles City Building Code shall be provided for anchor installations.

7. The use of zinc-coated carbon steel KB-TZ anchors is limited to dry and interior locations.

8. The anchors are not approved for masonry application.

9. Calculations demonstrating that the applied loads or factored loads are less than the allowable load values or design strength level values respectively, described in this report shall be submitted to the plan check Engineer at the time of permit application. The calculations shall be prepared by a Civil or Structural Engineer registered in the State of California.

    EXCEPTION: Anchors used for the installation of mechanical, plumbing and electrical equipment may be designed and detailed on a plan prepared by an engineer licensed by the state of California.

10. The anchors shall be installed at a minimum nominal embedment depth, h_{nom} , (see Figure 2 and Table 1) prior to tightening the anchor. This is to ensure that the minimum effective embedment, h_{ef}, of the expansion element (as shown in figure 2) is provided after the anchor has been torqued. The approved plans shall include a detailed drawing showing the required installation depth.

DISCUSSION

The technical modification is to adopt changes in 2011 LABC. Condition 10 has been added to clarify the installation depth vs. the effective depth.

The report is in compliance with the 2011 City of Los Angeles Building Code.

The approval is based on load tests. The anchors have been tested in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193), dated January 2007 (ACI 355.2) for static and dynamic loads and ASTM E488.

This general approval will remain effective provided the Evaluation Report is maintained valid and unrevised with the issuing organization. Any revisions to this report must be submitted to this Department, with appropriate fee, for review in order to continue the approval of the revised report.

Addresses to whom this Research Report is issued is responsible for providing copies of it, complete with any attachments indicated, to architects, engineers and builders using items approved herein in design or construction which must be approved by Department of Building and Safety Engineers and Inspectors.

This general approval of an equivalent alternate to the Code is only valid where an engineer and/or inspector of this Department has determined that all conditions of this approval have been met in the project in which it is to be used.

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5A1/1911/1912

Attachment: ICC ICC ES Evaluation Report No. ESR-1917 (11 pages)

ICC-ES Evaluation Report

ESR-1917

Reissued May 1, 2011

This report is subject to renewal in two years.

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DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

REPORT HOLDER:

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EVALUATION SUBJECT:

HILTI KWIK BOLT TZ CARBON AND STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009 and 2006 *International Building Code®* (IBC)
- * 2009 ~~and 2006 *International Residential Code®* (IRC)~~

Property evaluated:

Structural

2.0 USES

The Hilti Kwik Bolt TZ anchor (KB-TZ) is used to resist static, wind, and seismic tension and shear loads in cracked and uncracked normal-weight concrete and sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa). The anchoring system complies with requirements for anchors installed in hardened concrete as described in Section 1912 of the IBC. The anchoring system is an alternative to cast-in-place anchors described in Sections 1911 of the IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 KB-TZ:

KB-TZ anchors are torque-controlled, mechanical expansion anchors. KB-TZ anchors consist of a stud (anchor body), wedge (expansion elements), nut, and washer. The anchor (carbon steel version) is illustrated in Figure 1. The stud is manufactured from carbon steel or AISI Type 304 or Type 316 stainless steel materials. Carbon steel KB-TZ anchors have a minimum 5 μm (0.0002 inch) zinc plating. The expansion elements for the carbon and stainless steel KB-TZ anchors are fabricated from Type 316 stainless steel. The hex nut for carbon steel conforms to ASTM A 563-04, Grade A, and the hex nut for stainless steel conforms to ASTM F 594.

The anchor body is comprised of a high-strength rod threaded at one end and a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion element which freely moves around the mandrel. The expansion element movement is restrained by the mandrel taper and by a collar. The anchor is installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor, the mandrel is drawn into the expansion element, which is in turn expanded against the wall of the drilled hole.

3.2 Concrete:

Normal-weight and sand-lightweight concrete must conform to Sections 1903 and 1905 of the IBC.

3.3 Steel Deck Panels:

Steel deck panels must be in accordance with the configuration in Figure 5 and have a minimum base steel thickness of 0.035 inch (0.899mm). Steel must comply with ASTM A 653/A 653M SS Grade 33 and have a minimum yield strength of 33,000 psi (228 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

4.1.1 General: Design strength of anchors complying with the 2009 IBC and Section R301.1.3 of the 2009 IRC must be determined in accordance with ACI 318-08 Appendix D and this report. Design strength of anchors complying with the 2006 IBC ~~and Section R301.1.3 of the 2006 IRC~~ * must be in accordance with ACI 318-05 Appendix D and this report. Design parameters provided in Tables 3 and 4 of this report are based on the 2009 IBC (ACI 318-08) unless noted otherwise in Sections 4.1.1 through 4.1.11.

The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3. Strength reduction factors, ϕ, as given in ACI 318 D.4.4 and noted in Tables 3 and 4 of this report, must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC and Section 9.2 of ACI 318. Strength reduction factors, ϕ, as given in ACI 318 D.4.5 must be used for load combinations calculated in accordance with ACI 318 Appendix C. An example calculation is provided in Figure 7. The value of f'_c used in the calculations must be limited to a maximum of 8,000 psi (55.2 MPa), in accordance with ACI 318 D.3.5.

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4.1.2 Requirements for Static Steel Strength in Tension: The nominal static steel strength, N_{sa}, of a single anchor in tension must be calculated in accordance with ACI 318 D.5.1.2. The resulting N_{sa} values are provided in Tables 3 and 4 of this report. Strength reduction factors ϕ corresponding to ductile steel elements may be used.

4.1.3 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} or N_{cbg}, respectively, must be calculated in accordance with ACI 318 D.5.2, with modifications as described in this section. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2, using the values of h_{ef} and k_{cr} as given in Tables 3 and 4. The nominal concrete breakout strength in tension in regions where analysis indicates no cracking in accordance with ACI 318 D.5.2.6 must be calculated with k_{uncr} as given in Tables 3 and 4 and with $\Psi_{c,N}$ = 1.0.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete breakout strength is not required.

4.1.4 Requirements for Static Pullout Strength in Tension: The nominal pullout strength of a single anchor in accordance with ACI 318 D.5.3.1 and D.5.3.2 in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, respectively, is given in Tables 3 and 4. For all design cases $\Psi_{c,P}$ = 1.0. In accordance with ACI 318 D.5.3, the nominal pullout strength in cracked concrete may be calculated in accordance with the following equation:

$$N_{p,f'_c} = N_{p,cr}\sqrt{\frac{f'_c}{2,500}} \quad \text{(lb, psi)} \qquad \text{(Eq-1)}$$

$$N_{p,f'_c} = N_{p,cr}\sqrt{\frac{f'_c}{17.2}} \quad \text{(N, MPa)}$$

In regions where analysis indicates no cracking in accordance with ACI 318 D.5.3.6, the nominal pullout strength in tension may be calculated in accordance with the following equation:

$$N_{p,f'_c} = N_{p,uncr}\sqrt{\frac{f'_c}{2,500}} \quad \text{(lb, psi)} \qquad \text{(Eq-2)}$$

$$N_{p,f'_c} = N_{p,uncr}\sqrt{\frac{f'_c}{17.2}} \quad \text{(N, MPa)}$$

Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Table 3 or Table 4, the pullout strength in tension need not be evaluated.

The nominal pullout strength in cracked concrete of the carbon steel KB-TZ installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 5, is given in Table 3. In accordance with ACI 318 D.5.3.2, the nominal pullout strength in cracked concrete must be calculated in accordance with Eq-1, whereby the value of $N_{p,deck,cr}$ must be substituted for $N_{p,cr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. The use of stainless steel KB-TZ anchors installed in the soffit of concrete on steel deck assemblies is beyond the scope of this report.

4.1.5 Requirements for Static Steel Strength in Shear: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318 D.6.1.2 is given in Table 3 and Table 4 of this report and must be used in lieu of the values derived by calculation from ACI 318, Eq. D-20. The shear strength $V_{sa,deck}$ of the carbon-steel KB-TZ as governed by steel failure of the KB-TZ installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 5, is given in Table 3.

4.1.6 Requirements for Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, respectively, must be calculated in accordance with ACI 318 D.6.2, with modifications as described in this section. The basic concrete breakout strength, V_b, must be calculated in accordance with ACI 318 D.6.2.2 based on the values provided in Tables 3 and 4. The value of l_e used in ACI 318 Eq. D-24 must be taken as no greater than the lesser of h_{ef} or $8d_a$.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete on steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete breakout strength in shear is not required.

4.1.7 Requirements for Static Concrete Pryout Strength in Shear: The nominal concrete pryout strength of a single anchor or group of anchors, V_{cp} or V_{cpg}, respectively, must be calculated in accordance with ACI 318 D.6.3, modified by using the value of k_{cp} provided in Tables 3 and 4 of this report and the value of N_{cb} or N_{cbg} as calculated in Section 4.1.3 of this report.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 5, calculation of the concrete pry-out strength in accordance with ACI 318 D.6.3 is not required.

4.1.8 Requirements for Seismic Design:

4.1.8.1 General: For load combinations including earthquake, the design must be performed in accordance with ACI 318 D.3.3, as modified by Section 1908.1. 9 of the 2009 IBC or Section 1908.1.16 of the 2006 IBC. The nominal steel strength and the nominal concrete breakout strength for anchors in tension, and the nominal concrete breakout strength and pryout strength for anchors in shear, must be calculated in accordance with ACI 318 D.5 and D.6, respectively, taking into account the corresponding values given in Tables 3 and 4. The anchors may be installed in Seismic Design Categories A through F of the IBC. The anchors comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-08 D.3.3.4, D.3.3.5 or D.3.3.6, or ACI 318-05 D.3.3.4 or D.3.3.5, as applicable.

4.1.8.2 Seismic Tension: The nominal steel strength and nominal concrete breakout strength for anchors in tension must be calculated in accordance with ACI 318 D.5.1 and ACI 318 D.5.2, as described in Sections 4.1.2 and 4.1.3 of this report. In accordance with ACI 318 D.5.3.2, the appropriate pullout strength in tension for seismic loads, N_{eq}, described in Table 4 or $N_{p,deck,cr}$ described in Table 3 must be used in lieu of N_p, as applicable. The value of N_{eq} or $N_{p,deck,cr}$ may be adjusted by calculation for concrete strength in accordance with Eq-1 and Section 4.1.4 whereby the value of $N_{p,deck,cr}$ must be substituted for $N_{p,cr}$ and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. If no values for N_{eq} or $N_{p,deck,cr}$ are given in Table 3 or Table 4, the static design strength values govern.

4.1.8.3 Seismic Shear: The nominal concrete breakout strength and pryout strength in shear must be calculated in accordance with ACI 318 D.6.2 and D.6.3, as described in Sections 4.1.6 and 4.1.7 of this report. In accordance with ACI 318 D.6.1.2, the appropriate value for nominal steel strength for seismic loads, V_{eq} described in Table 3 and Table 4 or $V_{sa,deck}$ described in Table 3 must be used in lieu of V_{sa}, as applicable.

4.1.9 Interaction of Tensile and Shear Forces: For anchors or groups of anchors that are subject to the effects of combined tension and shear forces, the design must be performed in accordance with ACI 318 D.7.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 D.8.1 and D.8.3, values of s_{min} and c_{min} as given in Tables 3 and 4 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thicknesses h_{min} as given in Tables 3 and 4 of this report must be used. Additional combinations for minimum edge distance c_{min} and spacing s_{min} may be derived by linear interpolation between the given boundary values as described in Figure 4.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, the anchors must be installed in accordance with Figure 5 and shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.11 Requirements for Critical Edge Distance: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout strength in tension for uncracked concrete, calculated in accordance with ACI 318 D.5.2, must be further multiplied by the factor $\Psi_{cp,N}$ as given by Eq-1:

$$\Psi_{cp,N} = \frac{c}{c_{ac}} \qquad \text{(Eq-3)}$$

whereby the factor $\Psi_{cp,N}$ need not be taken as less than $\frac{1.5h_{ef}}{c_{ac}}$. For all other cases, $\Psi_{cp,N}$ = 1.0. In lieu of using ACI 318 D.8.6, values of c_{ac} must comply with Table 3 or Table 4.

4.1.12 Sand-lightweight Concrete: For ACI 318-08, when anchors are used in sand-lightweight concrete, the modification factor λ for concrete breakout strength must be taken as 0.6. In addition the pullout strength $N_{p,cr}$, $N_{p,uncr}$ and N_{eq} must be multiplied by 0.6, as applicable.

For ACI 318-05, the values N_b, $N_{p,cr}$, $N_{p,uncr}$, N_{eq} and V_b determined in accordance with this report must be multiplied by 0.6, in lieu of ACI 318 D.3.4.

For carbon steel KB-TZ anchors installed in the soffit of sand-lightweight concrete-filled steel deck and floor and roof assemblies, this reduction is not required. Values are presented in Table 3 and installation details are show in Figure 5.

4.2 Allowable Stress Design:

4.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC, must be established as follows:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha}$$

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

$T_{allowable,ASD}$ = Allowable tension load (lbf or kN).

$V_{allowable,ASD}$ = Allowable shear load (lbf or kN).

ϕN_n = Lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 D. 4.1, and the 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

ϕV_n = Lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 D.4.1, and the 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, described in this report, must apply. An example of allowable stress design values for illustrative purposes in shown in Table 6.

4.2.2 Interaction of Tensile and Shear Forces: The interaction must be calculated and consistent with ACI 318 D.7 as follows:

For shear loads $V \leq 0.2V_{allowable,ASD}$, the full allowable load in tension must be permitted.

For tension loads $T \leq 0.2T_{allowable,ASD}$, the full allowable load in shear must be permitted.

For all other cases:

$$\frac{T}{T_{allowable,ASD}} + \frac{V}{V_{allowable,ASD}} \leq 1.2 \qquad \text{(Eq-4)}$$

4.3 Installation:

Installation parameters are provided in Table 1 and Figures 2 and 5. Anchor locations must comply with this report and plans and specifications approved by the code official. The Hilti KB-TZ must be installed in accordance with manufacturer's published instructions and this report. In case of conflict, this report governs. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The minimum drilled hole depth is given in Table 1. Prior to installation, dust and debris must be removed from the drilled hole to enable installation to the stated embedment depth. The anchor must be hammered into the predrilled hole until h_{nom} is achieved. The nut must be tightened against the washer until the torque values specified in Table 1 are achieved. For installation in the soffit of concrete on steel deck assemblies, the hole diameter in the steel deck not exceed the diameter of the hole in the concrete by more than $^1/_8$ inch (3.2 mm). For member thickness and edge distance restrictions for installations into the soffit of concrete on steel deck assemblies, see Figure 5.

4.4 Special Inspection:

Special inspection is required in accordance with Section 1704.15 of the 2009 IBC and Section 1704.13 of the 2006 IBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, anchor spacing, edge distances, concrete member thickness, tightening torque, hole dimensions, anchor embedment and adherence to the manufacturer's printed installation instructions. The special inspector must be present as often as required in accordance with the "statement of special inspection." Under the IBC, additional requirements as set forth in Sections 1705 and 1706 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Hilti KB-TZ anchors described in this report comply with the codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Anchor sizes, dimensions and minimum embedment depths are as set forth in this report.

5.2 The anchors must be installed in accordance with the manufacturer's published instructions and this report. In case of conflict, this report governs.

5.3 Anchors must be limited to use in cracked and uncracked normal-weight concrete and sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa), and cracked and uncracked normal-weight or sand-lightweight concrete over metal deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.4 The values of f'_c used for calculation purposes must not exceed 8,000 psi (55.1 MPa).

5.5 Strength design values must be established in accordance with Section 4.1 of this report.

5.6 Allowable design values are established in accordance with Section 4.2.

5.7 Anchor spacing and edge distance as well as minimum member thickness must comply with Tables 3 and 4.

5.8 Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.10 Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.

5.11 Anchors may be used to resist short-term loading due to wind or seismic forces in locations designated as Seismic Design Categories A through F of the IBC, subject to the conditions of this report.

5.12 Where not otherwise prohibited in the code, KB-TZ anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- Anchors that support a fire-resistance-rated envelope or a fire- resistance-rated membrane are protected by approved fire-resistance- rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchors are used to support nonstructural elements.

5.13 Use of zinc-coated carbon steel anchors is limited to dry, interior locations.

5.14 Special inspection must be provided in accordance with Section 4.4.

5.15 Anchors are manufactured by Hilti AG under an approved quality control program with inspections by Underwriters Laboratories Inc. (AA-668).

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated November 2010 (ACI 355.2-07).

6.2 Quality control documentation.

7.0 IDENTIFICATION

The anchors are identified by packaging labeled with the manufacturer's name (Hilti, Inc.) and contact information, anchor name, anchor size, evaluation report number (ICC-ES ESR-1917), and the name of the inspection agency (Underwriters Laboratories Inc.). The anchors have the letters KB-TZ embossed on the anchor stud and four notches embossed into the anchor head, and these are visible after installation for verification.

TABLE 1—SETTING INFORMATION (CARBON STEEL AND STAINLESS STEEL ANCHORS)

SETTING INFORMATION	Symbol	Units	Nominal anchor diameter (in.)													
			3/8			1/2				5/8				3/4		
Anchor O.D.	d_a $(d_o)^2$	In. (mm)	0.375 (9.5)			0.5 (12.7)				0.625 (15.9)				0.75 (19.1)		
Nominal bit diameter	d_{bit}	In.	3/8			1/2				5/8				3/4		
Effective min. embedment	h_{ef}	In. (mm)	2 (51)			2 (51)	3-1/4 (83)			3-1/8 (79)	4 (102)			3-3/4 (95)	4-3/4 (121)	
Nominal embedment	h_{nom}	in. (mm)	2-5/16 (59)			2-3/8 (60)	3-5/8 (91)			3-9/16 (91)	4-7/16 (113)			4-5/16 (110)	5-9/16 (142)	
Min. hole depth	h_o	In. (mm)	2-5/8 (67)			2-5/8 (67)	4 (102)			3-7/8	4-3/4 (121)			4-5/8	5-3/4 (146)	
Min. thickness of fastened part[1]	t_{min}	In. (mm)	1/4 (6)			3/4 (19)	1/4 (6)			3/8 (9)	3/4 (19)			1/8 (3)	1 5/8 (41)	
Required Installation torque	T_{inst}	ft-lb (Nm)	25 (34)			40 (54)				60 (81)				110 (149)		
Min. dia. of hole in fastened part	d_h	In. (mm)	7/16 (11.1)			9/16 (14.3)				11/16 (17.5)				13/16 (20.6)		
Standard anchor lengths	ℓ_{anch}	In. (mm)	3 (76)	3-3/4 (95)	5 (127)	3-3/4 (95)	4-1/2 (114)	5-1/2 (140)	7 (178)	4-3/4 (121)	6 (152)	8-1/2 (216)	10 (254)	5-1/2 (140)	8 (203)	10 (254)
Threaded length (incl. dog point)	ℓ_{thread}	In. (mm)	7/8 (22)	1-5/8 (41)	2-7/8 (73)	1-5/8 (41)	2-3/8 (60)	3-3/8 (86)	4-7/8 (124)	1-1/2 (38)	2-3/4 (70)	5-1/4 (133)	6-3/4 (171)	1-1/2 (38)	4 (102)	6 (152)
Unthreaded length	ℓ_{unthr}	In. (mm)	2-1/8 (54)			2-1/8 (54)				3-1/4 (83)				4 (102)		

**

[1]The minimum thickness of the fastened part is based on use of the anchor at minimum embedment and is controlled by the length of thread. If a thinner fastening thickness is required, increase the anchor embedment to suit.
[2]The notation in parenthesis is for the 2006 IBC.

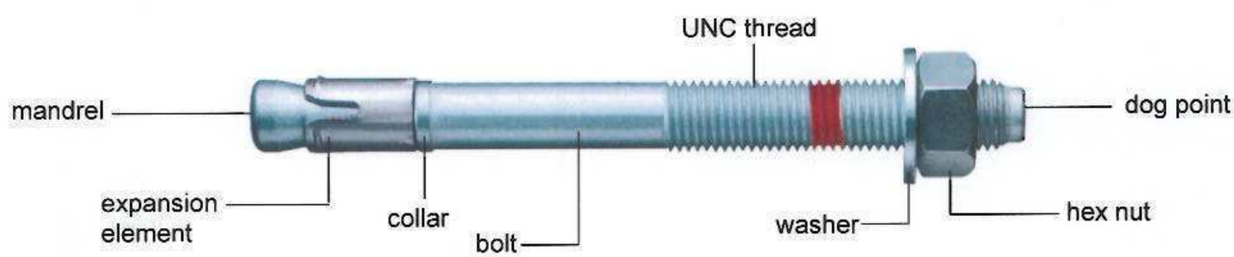

FIGURE 1—HILTI CARBON STEEL KWIK BOLT TZ (KB-TZ)

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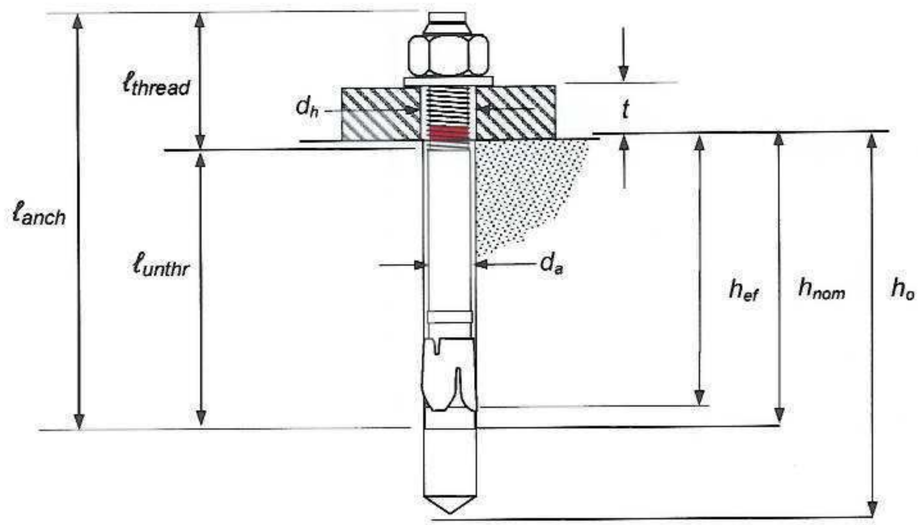

FIGURE 2—KB-TZ INSTALLED

TABLE 2—LENGTH IDENTIFICATION SYSTEM (CARBON STEEL AND STAINLESS STEEL ANCHORS)

Length ID marking on bolt head		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Length of anchor, ℓ_{anch} (inches)	From	1 ½	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15
	Up to but not including	2	2 ½	3	3 ½	4	4 ½	5	5 ½	6	6 ½	7	7 ½	8	8 ½	9	9 ½	10	11	12	13	14	15	16

FIGURE 3—BOLT HEAD WITH LENGTH IDENTIFICATION CODE AND KB-TZ HEAD NOTCH EMBOSSMENT

TABLE 3—DESIGN INFORMATION, CARBON STEEL KB-TZ

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	$d_a(d_o)$	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective min. embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness[2]	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	4 (102)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	6-1/2 (165)	8-3/4 (222)	6-3/4 (171)	10 (254)	8 (203)	9 (229)
Min. edge distance	c_{min}	In. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-5/8 (92)	3-1/4 (83)		4-3/4 (121)		4-1/8 (105)
	for $s \geq$	in. (mm)	5 (127)		5-3/4 (146)		5-3/4 (146)		6-1/8 (156)	5-7/8 (149)		10-1/2 (267)		8-7/8 (225)
Min. anchor spacing	s_{min}	in. (mm)	2-1/2 (64)		2-3/4 (70)		2-3/8 (60)		3-1/2 (89)	3 (76)		5 (127)		4 (102)
	for $c \geq$	In. (mm)	3-5/8 (92)		4-1/8 (105)		3-1/2 (89)		4-3/4 (121)	4-1/4 (108)		9-1/2 (241)		7-3/4 (197)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-7/8	4-3/4 (121)		4-5/8		5-3/4 (146) **
Min. specified yield strength	f_y	lb/in² (N/mm²)	100,000 (690)		84,800 (585)				84,800 (585)			84,800 (585)		
Min. specified ult. strength	f_{uta}	lb/in² (N/mm²)	115,000 (793)		106,000 (731)				106,000 (731)			106,000 (731)		
Effective tensile stress area	$A_{se,N}$	In² (mm²)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	6,500 (28.9)		10,705 (47.6)				17,170 (76.4)			25,120 (111.8)		
Steel strength in shear	V_{sa}	lb (kN)	3,595 (16.0)		5,495 (24.4)				8,090 (36.0)			13,675 (60.8)		
Steel strength in shear, seismic[3]	V_{eq}	lb (kN)	2,255 (10.0)		5,495 (24.4)				7,600 (33.8)			11,745 (52.2)		
Steel strength in shear, concrete on metal deck[4]	$V_{sa,deck}$	lb (kN)	2,130[12] (9.5)		3,000 (13.3)		4,945 (22)		4,600[12] (20.5)	6,040[12] (26.9)		NP		NP
Pullout strength uncracked concrete[5]	$N_{p,uncr}$	lb (kN)	2,515 (11.2)		NA		5,515 (24.5)		NA	9,145 (40.7)		8,280 (36.8)		10,680 (47.5)
Pullout strength cracked concrete[5]	$N_{p,cr}$	lb (kN)	2,270 (10.1)		NA		4,915 (21.9)		NA	NA		NA		NA
Pullout strength concrete on metal deck[6]	$N_{p,deck,cr}$	lb (kN)	1,460 (6.5)		1,460 (6.5)		2,620 (11.7)		2,000 (8.9)	4,645 (20.7)		NP		NP
Anchor category[7]			1											
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[8]			17											
$\Psi_{c,N} = k_{uncr}/k_{cr}$ [9]			1.0											
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction factor ϕ for tension, steel failure modes[10]			0.75											
Strength reduction factor ϕ for shear, steel failure modes[10]			0.65											
Strength reduction ϕ factor for tension, concrete failure modes or pullout, Condition B[11]			0.65											
Strength reduction ϕ factor for shear, concrete failure modes, Condition B[11]			0.70											

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa For pound-inch units: 1 mm = 0.03937 inches.

[1]See Fig. 2.
[2]For sand-lightweight concrete over metal deck, see Figure 5.
[3]See Section 4.1.8 of this report.
[4]See Section 4.1.5. NP (not permitted) denotes that the condition is not supported by this report.
[5]For all design cases $\Psi_{c,P}$=1.0. NA (not applicable) denotes that this value does not control for design. See Section 4.1.4 of this report.
[6]See Section 4.1.4 of this report. NP (not permitted) denotes that the condition is not supported by this report. Values are for cracked concrete. Values are applicable to both static and seismic load combinations.
[7]See ACI 318 Section D.4.4.
[8]See ACI 318Section D.5.2.2.
[9]For all design cases $\Psi_{c,N}$ =1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.
[10]The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
[11]For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 Section D.4.4 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
[12]For seismic applications according to Section 4.1.8 of this report multiply the value of $V_{sa,deck}$ for the 3/8-inch-diameter by 0.63 and the 5/8-inch-diameter by 0.94.

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TABLE 4—DESIGN INFORMATION, STAINLESS STEEL KB-TZ

DESIGN INFORMATION	Symbol	Units	Nominal anchor diameter											
			3/8		1/2				5/8			3/4		
Anchor O.D.	$d_a(d_o)$	in. (mm)	0.375 (9.5)		0.5 (12.7)				0.625 (15.9)			0.75 (19.1)		
Effective min. embedment[1]	h_{ef}	in. (mm)	2 (51)		2 (51)		3-1/4 (83)		3-1/8 (79)	4 (102)		3-3/4 (95)		4-3/4 (121)
Min. member thickness	h_{min}	in. (mm)	4 (102)	5 (127)	4 (102)	6 (152)	6 (152)	8 (203)	5 (127)	6 (152)	8 (203)	6 (152)	8 (203)	8 (203)
Critical edge distance	c_{ac}	in. (mm)	4-3/8 (111)	3-7/8 (98)	5-1/2 (140)	4-1/2 (114)	7-1/2 (191)	6 (152)	7 (178)	8-7/8 (225)	6 (152)	10 (254)	7 (178)	9 (229)
Min. edge distance	c_{min}	in. (mm)	2-1/2 (64)		2-7/8 (73)		2-1/8 (54)		3-1/4 (83)	2-3/8 (60)		4-1/4 (108)		4 (102)
	for $s \geq$	in. (mm)	5 (127)		5-3/4 (146)		5-1/4 (133)		5-1/2 (140)	5-1/2 (140)		10 (254)		8-1/2 (216)
Min. anchor spacing	s_{min}	in. (mm)	2-1/4 (57)		2-7/8 (73)		2 (51)		2-3/4 (70)	2-3/8 (60)		5 (127)		4 (102)
	for $c \geq$	in. (mm)	3-1/2 (89)		4-1/2 (114)		3-1/4 (83)		4-1/8 (105)	4-1/4 (108)		9-1/2 (241)		7 (178)
Min. hole depth in concrete	h_o	in. (mm)	2-5/8 (67)		2-5/8 (67)		4 (102)		3-7/8	4-3/4 (121)		4-5/8		5-3/4 (146) **
Min. specified yield strength	f_y	lb/in² (N/mm²)	92,000 (634)		92,000 (634)				92,000 (634)			76,125 (525)		
Min. specified ult. Strength	f_{uta}	lb/in² (N/mm²)	115,000 (793)		115,000 (793)				115,000 (793)			101,500 (700)		
Effective tensile stress area	$A_{se,N}$	in² (mm²)	0.052 (33.6)		0.101 (65.0)				0.162 (104.6)			0.237 (152.8)		
Steel strength in tension	N_{sa}	lb (kN)	5,968 (26.6)		11,554 (51.7)				17,880 (82.9)			24,055 (107.0)		
Steel strength in shear	V_{sa}	lb (kN)	4,720 (21.0)		6,880 (30.6)				9,870 (43.9)			15,711 (69.9)		
Pullout strength in tension, seismic[2]	N_{eq}	lb (kN)	NA		2,735 (12.2)		NA		NA			NA		
Steel strength in shear, seismic[2]	V_{eq}	lb (kN)	2,825 (12.6)		6,880 (30.6)				9,350 (41.6)			12,890 (57.3)		
Pullout strength uncracked concrete[3]	$N_{p,uncr}$	lb (kN)	2,630 (11.7)		NA		5,760 (25.6)		NA			NA		12,040 (53.6)
Pullout strength cracked concrete[3]	$N_{p,cr}$	lb (kN)	2,340 (10.4)		3,180 (14.1)		NA		NA	5,840 (26.0)		8,110 (36.1)		NA
Anchor category[4]			1		2		1							
Effectiveness factor k_{uncr} uncracked concrete			24											
Effectiveness factor k_{cr} cracked concrete[5]			17		24		17		17	17		24		17
$\Psi_{C,N} = k_{uncr}/k_{cr}$ [6]			1.0											
Strength reduction factor ϕ for tension, steel failure modes[7]			0.75											
Strength reduction factor ϕ for shear, steel failure modes[7]			0.65											
Strength reduction ϕ factor for tension, concrete failure modes, Condition B[8]			0.65		0.55		0.65							
Coefficient for pryout strength, k_{cp}			1.0				2.0							
Strength reduction ϕ factor for shear, concrete failure modes, Condition B[8]			0.70											

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 psi = 0.006895 MPa For pound-inch units: 1 mm = 0.03937 inches.

[1]See Fig. 2.
[2]See Section 4.1.8 of this report. NA (not applicable) denotes that this value does not control for design.
[3]For all design cases $\Psi_{c,P}$ =1.0. NA (not applicable) denotes that this value does not control for design. See Section 4.1.4 of this report.
[4]See ACI 318 Section D.4.4.
[5]See ACI 318 Section D.5.2.2.
[6]For all design cases $\Psi_{c,N}$ =1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.
[7]The KB-TZ is a ductile steel element as defined by ACI 318 D.1.
[8]For use with the load combinations of ACI 318 Section 9.2. Condition B applies where supplementary reinforcement in conformance with ACI 318 Section D.4.4 is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

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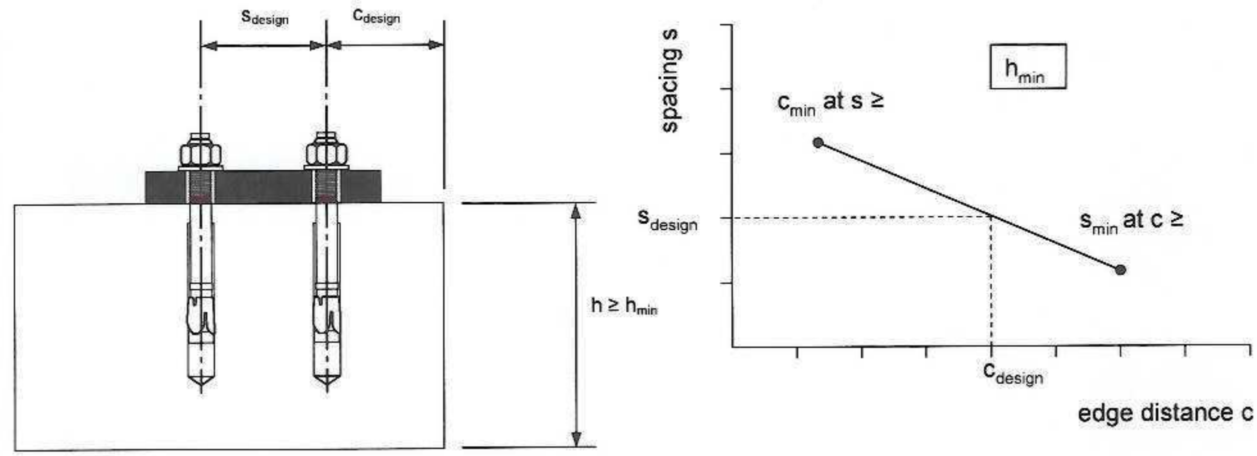


FIGURE 4—INTERPOLATION OF MINIMUM EDGE DISTANCE AND ANCHOR SPACING

TABLE 5—MEAN AXIAL STIFFNESS VALUES β FOR KB-TZ CARBON AND STAINLESS STEEL ANCHORS IN NORMAL-WEIGHT CONCRETE (10^3pounds/in.)[1]

Concrete condition	carbon steel KB-TZ, all diameters	stainless steel KB-TZ, all diameters
uncracked concrete	700	120
cracked concrete	500	90

[1]Mean values shown, actual stiffness may vary considerably depending on concrete strength, loading and geometry of application.

TABLE 6—EXAMPLE ALLOWABLE STRESS DESIGN VALUES FOR ILLUSTRATIVE PURPOSES

Nominal Anchor diameter (in.)	Embedment depth (in.)	Allowable tension (lbf)	
		Carbon Steel	Stainless Steel
		f '$_c$ = 2500 psi	
		Carbon Steel	Stainless Steel
3/8	2	1105	1155
1/2	2	1490	1260
	3-1/4	2420	2530
5/8	3-1/8	2910	2910
	4	4015	4215
3/4	3-3/4	3635	3825
	4-3/4	4690	5290

For **SI:** 1 lbf = 4.45 N, 1 psi = 0.00689 MPa 1 psi = 0.00689 MPa. 1 inch = 25.4 mm.

[1]Single anchors with static tension load only.
[2]Concrete determined to remain uncracked for the life of the anchorage.
[3]Load combinations from ACI 318 Section 9.2 (no seismic loading).
[4]30% dead load and 70% live load, controlling load combination 1.2D + 1.6 L.
[5]Calculation of the weighted average for α = 0.3*1.2 + 0.7*1.6 = 1.48.
[6]f '$_c$ = 2,500 psi (normal weight concrete).
[7]$c_{a1} = c_{a2} \geq c_{ac}$
[8]$h \geq h_{min}$
[9]Values are for Condition B where supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided

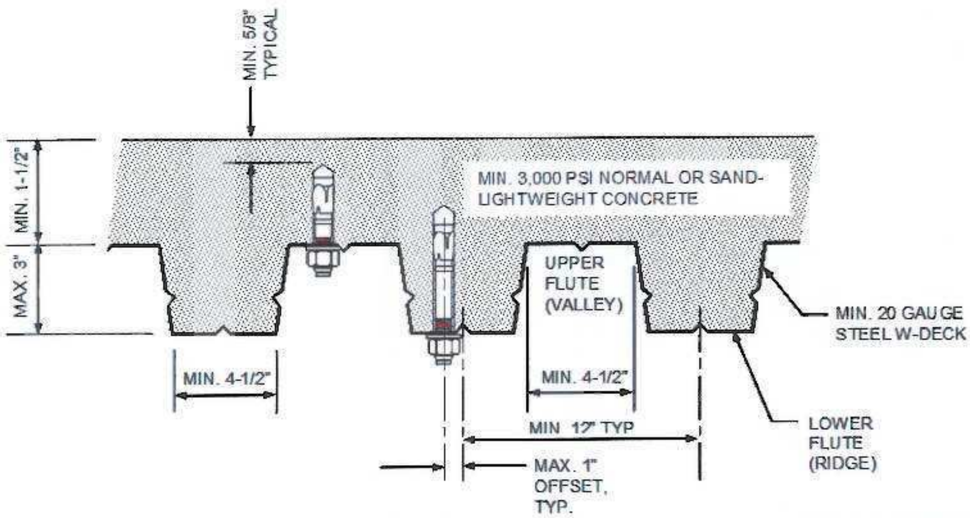
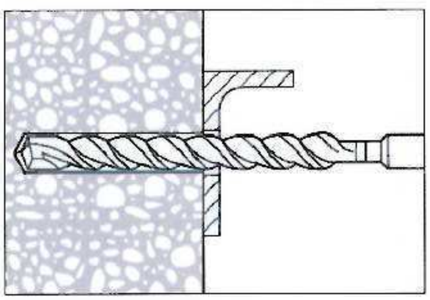
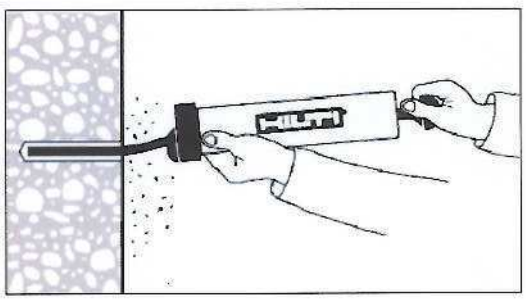


FIGURE 5—INSTALLATION IN THE SOFFIT OF CONCRETE OVER METAL DECK FLOOR AND ROOF ASSEMBLIES[1]

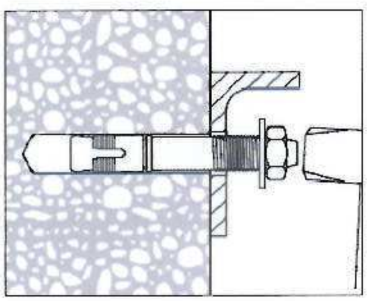
[1]Anchors may be placed in the upper or lower flute of the steel deck profile provided the minimum hole clearance is satisfied. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from the center of the flute.



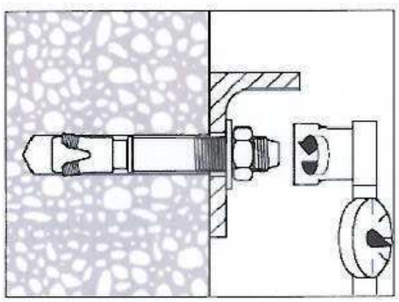
1. Hammer drill a hole to the same nominal diameter as the Kwik Bolt TZ. The hole depth must equal the anchor embedment listed in Table 1. The fixture may be used as a drilling template to ensure proper anchor location.



2. Clean hole.



3. Drive the Kwik Bolt TZ into the hole using a hammer. The anchor must be driven until the nominal embedment is achieved.

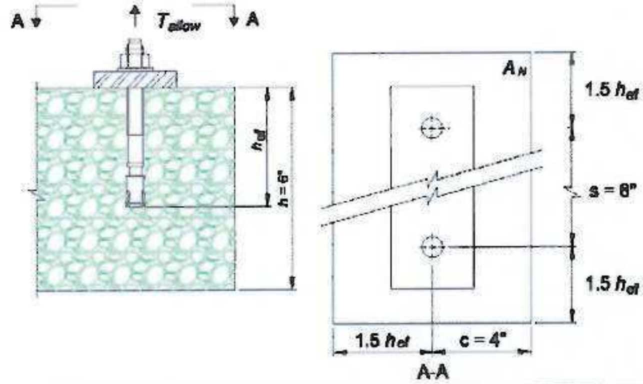


4. Tighten the nut to the required installation torque.

FIGURE 6 – INSTALLATION INSTRUCTIONS

Given:
Two 1/2-inch carbon steel KB-TZ anchors under static tension load as shown.
h_{ef} = 3.25 in.
Normal weight concrete, f'_c = 3,000 psi
No supplementary reinforcement (Condition B per ACI 318 D.4.4 c)
Assume cracked concrete since no other information is available.

Needed: Using Allowable Stress Design (ASD) calculate the allowable tension load for this configuration.



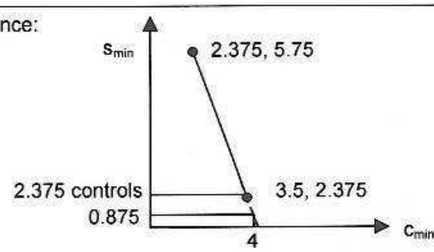
Calculation per ACI 318-08 Appendix D and this report.	Code Ref.	Report Ref.
Step 1. Calculate steel capacity: $\phi N_s = \phi n A_{se} f_{ut} = 0.75 \times 2 \times 0.101 \times 106{,}000 = 16{,}059 \text{lb}$ Check whether f_{ut} is not greater than $1.9f_{ya}$ and 125,000 psi.	D.5.1.2 D.4 .4 a)	§4.1.2 Table 3
Step 2. Calculate concrete breakout strength of anchor in tension: $$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$$	D.5.2.1	§ 4.1.3
Step 2a. Verify minimum member thickness, spacing and edge distance: h_{min} = 6 in. ≤ 6 in. ∴ ok slope = $\frac{2.375 - 5.75}{3.5 - 2.375}$ = -3.0 For c_{min} = 4in ⇒ $s_{min} = 5.75 - [(2.375 - 4.0)(-3.0)] = 0.875 < 2.375\text{in} < 6\text{in} \therefore \text{ok}$  	D.8	Table 3 Fig. 4
Step 2b. For A_N check $1.5h_{ef} = 1.5(3.25) = 4.88 \text{ in} > c$ $\quad 3.0h_{ef} = 3(3.25) = 9.75 \text{ in} > s$	D.5.2.1	Table 3
Step 2c. Calculate A_{Nco} and A_{Nc} for the anchorage: $A_{Nco} = 9h_{ef}^2 = 9 \times (3.25)^2 = 95.1 in.^2$ $A_{Nc} = (1.5h_{ef} + c)(3h_{ef} + s) = [1.5 \times (3.25) + 4][3 \times (3.25) + 6] = 139.8 in.^2 < 2A_{Nco} \therefore ok$	D.5.2.1	Table 3
Step 2d. Determine $\psi_{ec,N}$: $e'_N = 0 \therefore \psi_{ec,N} = 1.0$	D.5.2.4	-
Step 2e. Calculate N_b: $N_b = k_{cr} \lambda \sqrt{f'_c} h_{ef}^{1.5} = 17 \times 1.0 \times \sqrt{3{,}000} \times 3.25^{1.5} = 5{,}456 \; lb$	D.5.2.2	Table 3
Step 2f. Calculate modification factor for edge distance: $\psi_{ed,N} = 0.7 + 0.3 \frac{4}{1.5(3.25)} = 0.95$	1.0 D.5.2.5	2.0 Table 3
3.0 Step 2g. Calculate modification factor for cracked concrete: $\psi_{c,N}$ =1.00 (cracked concrete)	D.5.2.6	Table 3
Step 2h. Calculate modification factor for splitting: $\psi_{cp,N}$ =1.00 (cracked concrete)	**3.1** -	**3.2** § 4.1.10 **3.3** Table 3
3.4 Step 2i. Calculate ϕN_{cbg} : $\phi N_{cbg} = 0.65 \times \frac{139.8}{95.1} \times 1.00 \times 0.95 \times 1.00 \times 5{,}456 = 4{,}952$ lb	D.5.2.1 D.4.4 c)	§ 4.1.3 Table 3
Step 3. Check pullout strength: Table 3, $\phi n N_{pn,f'c} = 0.65 \times 2 \times 5{,}515 \text{ lb} \times \sqrt{\frac{3{,}000}{2{,}500}} = 7{,}852$ lb >4,952 ∴ OK	D.5.3.2 D.4.4 c)	§ 4.1.4 Table 3
Step 4. Controlling strength: ϕN_{cbg} = 4,952 lb < $\phi n N_{pn}$ < ϕN_s ∴ ϕN_{cbg} controls	D.4.1.2	Table 3
Step 5. To convert to ASD, assume U = 1.2D + 1.6L: $T_{allow} = \frac{4{,}952}{1.48}$ = 3,346 lb.	-	§ 4.2

FIGURE 7—EXAMPLE CALCULATION